SPECTRAL WAVE DECAY DUE TO BOTTOM FRICTION ON THE INNER SHELF

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LONG-TERM GOALS

My long term goals are to observe and model wave and boundary layer processes which contribute to turbulent mixing and wave modification in the coastal ocean and nearshore using new instrumentation techniques.

SCIENTIFIC OBJECTIVES

The primary scientific objective of this project is to measure the bottom dissipation of surface gravity waves as they shoal across the continental shelf. Observations from several field sites with differing wave forcing, mean currents and sediment types will be used to evolve a spectral wave dissipation model for the continental shelf including parameterizations for low frequency currents.

APPROACH

At each of the field deployment sites, dissipation in the bottom boundary layer and wave / current forcing are being measured with a hierarchy of acoustic-based instrumentation including a cm-resolution, three component Bistatic Coherent Doppler Velocimeter (BCDV) (Stanton 1996 and Stanton 1997) which measures vertical profiles of velocity and sediment concentration over a 60cm range above the bed at a 48Hz rate. These small scale measurements of the bottom boundary layer are extended through the water column with *in situ* travel-time current sensors and up to the ocean surface with a high speed BADCP. Wave dissipation rates in the mean current and wave-forced bottom boundary layer are being estimated by decomposing mean, wave, and turbulent components of the three component velocity vector to estimate the dissipative components of the fluid motion. The co-located measurements of the velocity vector profiles and sediment concentration allow the sediment buoyancy terms in the TKE balance in the bottom boundary to be estimated when sediment suspension is occurring. As the local sediment morphology can greatly influence the characteristics of the bottom boundary layer (for example Faria *et al* 1997), a two axis scanning sonar altimeter has been developed to measure quantitatively measure finescale morphology over a 4 by 2m area centered on the BCDV profile measurements with 4cm horizontal resolution. These local morphology maps are extended by qualitative 2D side-scan morphology images out to a 20m radius.

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WORK COMPLETED

The BCDV and scanning altimeter were successfully deployed on an instrumented sled during the SANDYDUCK nearshore experiment at Duck, NC during September and October 1997. Each day the sled was hauled offshore beyond the sand bar to approximately 4m depth, and moved onshore every hour to occupy measurement points spanning the nearshore region to study a range of sediment transport and wave transformation processes. Approximately half of the offshore measurement sites were representative of inner shelf, shoaling wave conditions, particularly on days with narrow banded swell. The prototype scanning sonar provided high resolution local maps of the morphology around the BCDV profiles, while a set of eight acoustic altimeters mounted on the the Army Corps of Engineers CRAB vehicle extended these local maps to an area 1km offshore and 2km alongshore while the CRAB performed large scale surveys of the SANDYDUCK site. Processing and analysis of this large data set proceeded while in the field at Duck.

RESULTS

Preliminary processing of the scanning altimeter and BCDV observations at SANDYDUCK have shown that both instruments performed very well, even in the strong wave forcing and bubble injection conditions experienced during storms in the surf zone. This experience suggests that the instruments will work well during the two month 10m depth deployment in the main Shoaling Waves DRI experiment at Duck in 1999.

The prototype BCDV resolved the bottom boundary adequately during these measurements, but a higher resolution instrument is currently being implemented. An example of a velocity profile timeseries in Figure 1c shows a characteristic stokes layer in the bottom boundary layer as the cross shore velocity changes direction and decelerates. Figure 1b shows evidence of rapid sedimentation events frequently seen during the decelerating part of the wave cycle, while the following sediment event is typical of cross-shore velocity maximum sediment events. Preliminary analysis of the SANDYDUCK data set suggest that the prototype BCDV will provide significant insight into the characterization of dissipation in the bottom boundary layer.

Figure 2 shows an example of the local morphology measured at the time of the velocity and sediment concentration timeseries in Figure 1. The raw titlt and range data have been transformed into vertical sled coordinates, and objectively mapped to produce timeseries of morphology maps. The vertical line shows the location of the BCDV profile. This example shows large scale along-shore aligned ripples which were characteristic of the nearshore region under moderate forcing conditions.

IMPACT / APPLICATIONS

Observations of cross shelf wave shoaling and energy changes across the continental shelf (for example Hendrickson 1996) suggest the need for improved observations and modelling of bottom dissipation in coastal regions. Modelling of bottom dissipation in coastal regions will directly improve shelf wave models, which have wide ranging navy and civilian applications.

TRANSITIONS

RELATED PROJECTS

This research has benefited from and contributed to the ONR-sponsored SANDYDUCK program in the development and deployment of sophisticated instrumentation to address overlapping issues in both programs.

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WEBSITE

http://www.oc.nps.navy.mil/~stanton/turblab.html

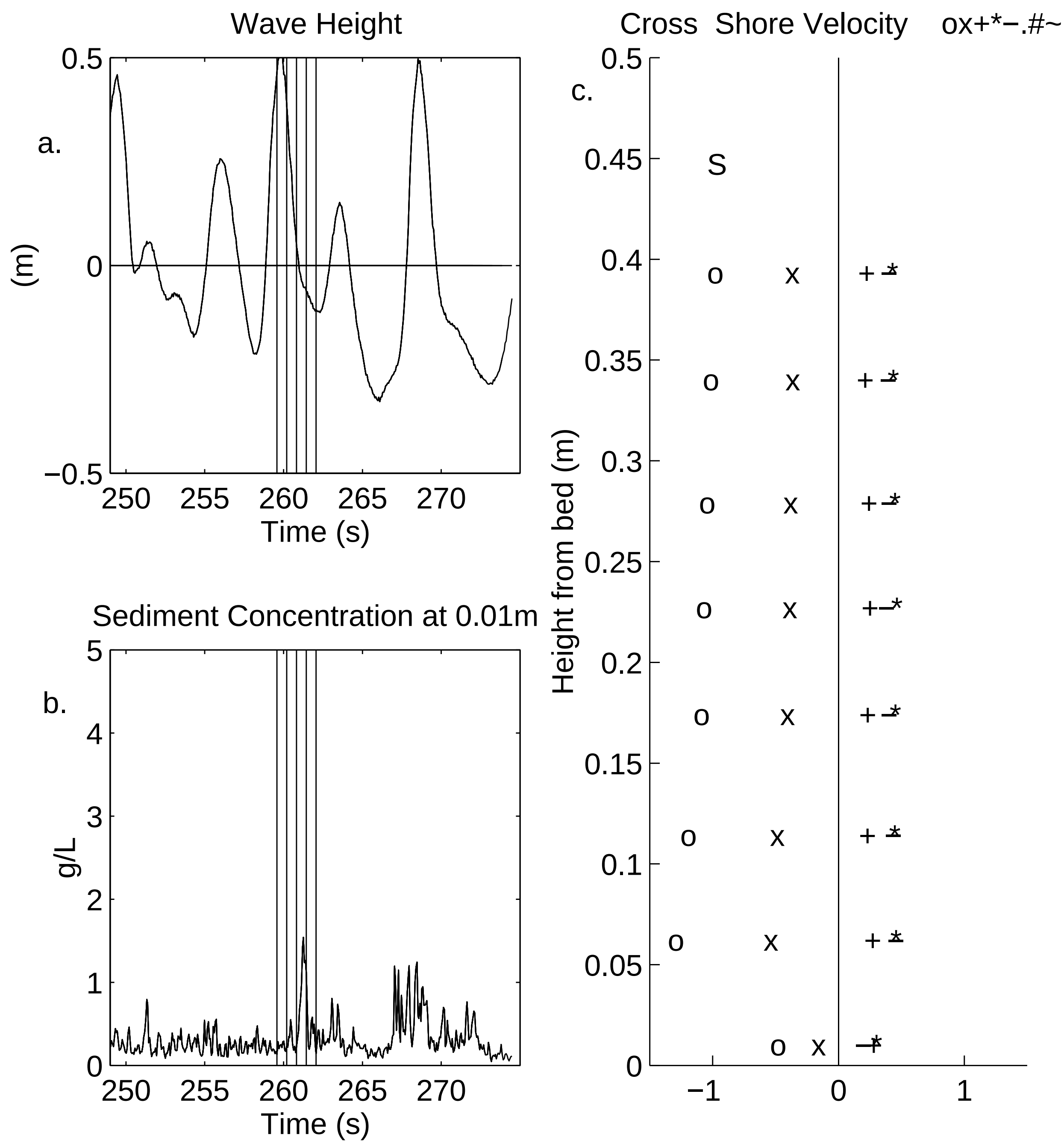

Figure 1 a.) A 25 second timeseries of wave height above the BCDV profile measurements. The vertical bars indicate the sample points for the profiles in Figure 1c. b.) The sediment concentration 1cm above the bed for the same time interval. c.) A vertical profile sequence of cross shore velocity, with time going left to right. The x axis represents velocity (ms^{-1}).

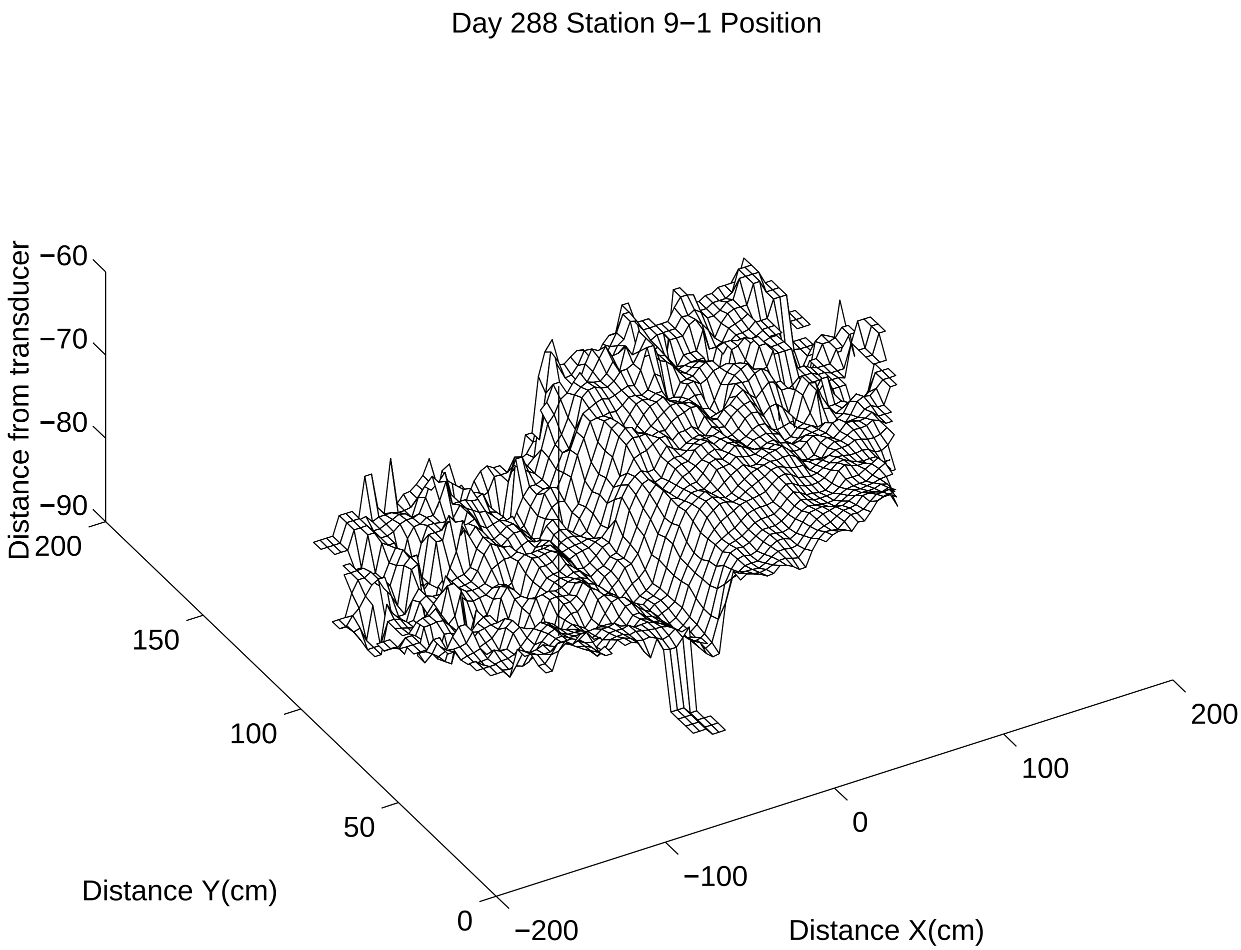

Figure 2 The local sand bed morphology around the BCDV profile measurements for the time of profiles shown in Figure 1. The x-axis is aligned cross shore, and the y is along shore. The vertical line represents the position of the BCDV profile observation.